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Controlling Air Toxics
An Advisory System

Radian Corp., Research Triangle Park, NC

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16. ABSTRACT The paper discusses the development and use of a computerized advisory system for the control of air toxics. The development is a joint product of EPA's Control Technology Center (itself a joint venture of EPA's Office of Research and Development and its Office of Air Quality Planning and Standards) and the New Jersey Department of Environmental Protection. The program, based on the engineering program described in EPA report, Control Technologies for Hazardous Air Pollutants, EPA/625/6-86-014, September 1986, is written for the IBM PC using Microsoft C V3.0 compiler and Windows for Data Library V1.0 for screen and keyboard interaction. The permit reviewer inputs information on the air emission stream characteristics as well as other information in the permit application. The program allows the permit reviewer to select a specific pollution control device for evaluation. The program then calculates design parameters and estimates costs for each control technology selected. The results can be compared against the applicant's actual or proposed design. The program is designed to easily allow what-if calculations, allowing the reviewer to change one or more parameters and recalculate the results. A report generator is included in the program.

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CONTROLLING AIR TOXICS, AN ADVISORY SYSTEM

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ABSTRACT

The Environmental Protection Agency's (EPA's) Control Technology Center (CTC) was established in 1987 to provide technical assistance to State and Local Air Pollution Control Agencies, particularly in the control of air toxics. The CTC is a joint venture between EPA's Office of Research and Development (ORD) and the Office of Air Quality Planning and Standards (OAQPS). One of the first projects undertaken by the CTC, in conjunction with the New Jersey Department of Environmental Protection (NJDEP), is a computerized advisory system for the control of air toxics. The engineering program is based on the EPA document, Control Technologies for Hazardous Air Pollutants, EPA/625/6-86/014, September 1986. This document has been used extensively by State and Local personnel with favorable results. In talking to the users and examining the document, it became apparent that the material in the document would be even more useful on a computer, eliminating the necessity of repetitively performing complex calculations. Soon after the conception of the project, it was discovered that the NJDEP was planning similar work. The two groups decided to work together to produce a system intended to assist permit reviewers across the country in the review of air emission permit applications.

The program was written for the IBM PC using Microsoft C V3.0 compiler and Windows for Data Library V1.0 for screen and keyboard interaction. The permit reviewer inputs information on the air emission stream characteristics as well as other information provided in the permit application. The program allows the permit reviewer to select a specific pollution control device for evaluation. The program then calculates design parameters and estimates costs for each control technology selected. The results can be compared against the applicant's actual or proposed design.

The program is designed to easily allow what-if type calculations, allowing the reviewer to change one or more parameters and recalculate the results. A report generator is included in the program. This paper will discuss the development of the program and its use.

INTRODUCTION

The Environmental Protection Agency (EPA) announced in June 1985 a strategy, which encompasses both routine and accidental release concerns, for a program to reduce public exposure to toxic air pollutants in the ambient air. The Air Toxics Strategy couples the traditional Federal regulatory programs [e.g., National Emission Standards for Hazardous Air Pollutants (NESHAPs), New Source Performance Standards (NSPS)] with an increasing State and Local regulatory responsibility to achieve reduced air toxics risk to the public. Over the next 5-8 years, the strategy calls for the States and Local authorities to take the lead regulatory role, with the Agency providing technical and financial assistance to their efforts. As a result of this shift in responsibility, EPA's 5-year Air Toxics Implementation Plan identifies enhancement of State and Local air toxics programs as one of six key components to accomplish EPA's strategy.

As State and Local air pollution authorities begin to develop localized air toxics regulations, substantial financial and technical assistance is expected to be required. The enhancement of State and Local Air Toxics Programs will provide financial assistance through grants (e.g., Section 105 of the Clean Air Act) and technical assistance through several EPA offices, including the engineering R&D program. In particular, experience in control technology and source assessment resident in the EPA will provide a prime source of technical expertise for the State and Local Agencies as they develop their air toxics programs.

The shift in emphasis and responsibility from the Federal level to the State and Local air toxics programs and the need to transfer expertise from the Federal level to the appropriate State or Local level prompted EPA's Office of Research and Development (ORD) and EPA's Office of Air Quality Planning and Standards (OAQPS) to develop and implement an innovative technical assistance program. This program began as an outgrowth of the needs identified in EPA's Air Toxics Implementation Plan and is called the Control Technology Center (CTC). The CTC is a collaborative effort among OAQPS and ORD's Air and Energy Engineering Research Laboratory (AEERL) and Center for Environmental Research Information (CERI). It is expected to become a principal element in the enhancement program through the early 1990s.

Shortly after the conception and implementation of the CTC, it became apparent that State and Local air pollution Agencies would not restrict their requests of the CTC to the limited area of air toxics. At that time, members of the CTC Steering Committee which manages the CTC made a conscious decision to be responsive rather than restrictive. That is, the CTC would be expanded as needed to answer the needs that were identified by State and Local air pollution Agencies. The resulting program includes technical assistance in the area of control of air

toxics and volatile organic compounds (VOCs), ozone nonattainment concerns, and other areas where expertise exists within OAQPS and ORD.

This paper will discuss one of the first projects selected by the CTC, undertaken in conjunction with the New Jersey Department of Environmental Protection (NJDEP). This paper will describe the cooperative effort between the two organizations; the resulting product, a microcomputer program to assist permit writers in the review of permit applications; and future plans for its development and use.

INITIATION OF THE PROJECT

The types of services to be provided by the CTC can be broken down into three categories: HOTLINE calls, direct engineering assistance, and technical guidance projects. The CTC HOTLINE is a special number which State and Local Agencies can call for easy access to EPA personnel who can provide prompt assistance in a variety of ways including discussions, references to pertinent literature, and referrals to other EPA personnel. In some cases, a HOTLINE call will require more in-depth engineering analysis, indicating a need for direct engineering assistance. These projects tend to be short-term (2 - 3 months) and specific in nature. In some cases several agencies may indicate a need for information on the same source, or a group such as the Northeast States for Coordinated Air Use Management may make a joint request. In these cases, the Steering Committee may decide that a technical guidance project is indicated. Technical guidance projects are longer-term and are intended to be of broad interest, useful to many agencies.

Some time ago, AEERL and CERI produced the EPA document, Control Technologies for Hazardous Air Pollutants, EPA/625/6-86/014, September 1986. This document discusses choosing the appropriate control technology for particulate and vapor emission streams and leads the reader, step-by-step, through the calculations required for design and cost estimations of 10 different control devices. Since release of the document, thousands of copies have been distributed. It has been used extensively by State and Local personnel with favorable results.

In talking to the users and examining the document, it became apparent that the material in the document would be even more useful on a computer, minimizing the time required for calculation and eliminating the necessity of repetitively using complex equations as well as the possibility of human mistakes in computations. The CTC Steering Committee agreed to fund a project to computerize or automate the manual.

Soon after the Steering Committee agreed to fund the project, it was discovered that the NJDEP had contracted with Radian Corporation to develop a similar system to help automate the permit review process for the State of New Jersey. With over 5000 permits to review per year, limited staff, and a goal of a 90-day turnaround per permit, NJDEP had to limit their engineering review to an average of 4 hours per permit. It was obvious that any automation of the permit review process would be extremely advantageous in time saving and would make for a more uniform, unbiased process.

Upon hearing of NJDEP's plans, the CTC decided to approach the State with a proposal to combine the projects. Although interagency agreements or other funding is never a condition for obtaining CTC assistance, the CTC is receptive to co-funding arrangements when mutually beneficial. In this particular case, the CTC had an available document to serve as a basis for the project, and NJDEP had the perspective of the permit reviewer, more fully understanding the needs of State and Local Agencies. The CTC requested that the program be written for IBM-compatible computers and that the program could be made available to any interested State or Local Agency. The two groups agreed to work together to produce a computer program to assist permit reviewers across the country in the review of air emission permit applications.

The CTC operating protocol requires that project teams be established to manage each project with representatives from at least two of the three participating organizations. For this project, AEERL assumed the lead with team members from OAQPS and NJDEP. The team chose 8 of the 10 control devices from the document for inclusion in the program. The user is encouraged to consider the manual to be used as a companion to the program since there is information in the document not included in the computer program. The eight control devices chosen for the program from the document are: thermal incinerators, catalytic incinerators, flares, carbon adsorbers, absorbers, condensers, fabric filters, and venturi scrubbers.

CONTROLLING AIR TOXICS (CAT)

The resulting program is called Controlling Air Toxics (CAT) and is written for the IBM PC using Microsoft C V3.0 compiler and Windows for Data Library V1.0 for screen and keyboard interaction. CAT requires a hard disk with 1 megabyte of available space, 640K of random access memory (RAM), and DOS 2.0 or higher.

The program is loaded by typing CAT at the DOS prompt in the sub-directory where the program resides. CAT uses a Lotus style menu which always appears at the top of the computer screen. Each menu option may be chosen by entering the first letter or using the arrow keys to highlight the choice and pressing [ENTER]. A description of each menu option is given below the menu option line, and the line below is used for instructions to the user. Figure 1 shows the tree structure of the menu. The seven options in the main menu are: Plant, Stream, Device, Review, File, Clear, and Quit. They will be discussed individually below with their sub-menus and corresponding options.

Plant

The first menu option allows the user to enter plant identification information. Figure 2 shows the Plant Identifying Data form below the main menu. The form is completed by typing on the keyboard. The arrow keys and [HOME] and [END] keys are used to move between fields. The form contains fields for the company name and address, the name and telephone number for the contact within the plant, and the reviewer. The form is saved and the user is returned to the main menu by pressing the [F10] key. The [ESC] key may be used to abandon the form without saving changes.

Stream

The sub-menu under the main menu option, Stream, has four options: Type, Parameters, HAP, and Clear. The purpose of the Stream option is to enter characteristics of the emission stream by entering its type, its physical parameters, and the pollutants it contains.

Type. The type of the emission stream must be specified before the user can proceed in the program. The choice of the stream type will influence the types of control devices which may be chosen later in the program. A pop-up window displays the available options: organic vapor, inorganic vapor, organic particulate, and inorganic particulate. A choice is made by highlighting the desired type and pressing [ENTER].

Parameters. The parameter option of the menu refers to the parameters describing the emission stream. The parameter form is shown in Figure 3.

Information for each parameter is entered by using the arrow keys to highlight each one and pressing [ENTER]. Selecting a parameter in this manner will cause a parameter form to pop up in the center of the screen with fields for each of the three columns associated with each parameter (Applicant value, Calculation value, and Checked), plus a Recommended value field as shown in Figure 4. The parameter name is given in the upper left-hand corner of the form and corresponds to the name in the manual for easy cross-reference. The value supplied by the permit applicant is used for the applicant value. It is used only for comparison purposes and is never used in any computation. The recommended value is a suggested default value. The user may not enter a recommended value, and the values are not available for every field. The calculation value should contain the value the user wishes to use for computation of the results. Normally this value should be the same as the applicant value. This will not be true if the applicant did not supply a value, or if the user chooses to study the effect of changing the value on the results. The checked field is a one-letter field which can be used as a code in several ways. For example, the letter, y, may be used to denote that the permit reviewer is in agreement with the value supplied by the applicant.

HAP. The Hazardous Air Pollutant (HAP) sub-menu is used to specify which HAPs occur in the emission stream and to specify the physical parameters for each. There are four options under this sub-menu: Generate, Review, Add, and Delete. The compounds used in the final evaluation are those resulting from the options below.

Generate. The CAT program contains a data base with over 600 standard industrial classification (SIC) codes and the HAPs commonly associated with each SIC code. A list of potential HAPs can be generated by highlighting an SIC code and pressing [ENTER]. The user may choose to add pollutants from more than one SIC code by continuing to execute the Generate option. The set of pollutants produced will be the union of the pollutants from the individual SIC categories.

Review. The list of pollutants which is currently selected may be

viewed on the computer screen by choosing this option from the menu.

Add. Another data base contained in the program is a list of about 350 chemicals, listed alphabetically with Chemical Abstract System (CAS) numbers. The list appears on the screen, and compounds can be selected by using the arrow keys to highlight the choice and pressing [ENTER]. The user may continue to select compounds in this manner. As each compound is chosen, it will be removed from the list of chemicals available for selection. When finished, the user may return to the main menu by pressing [ESC].

Delete. Pollutants may be removed from the list of currently selected compounds by using the Delete option. The pollutants currently chosen will appear. Each pollutant selected will be deleted from the stream and from the menu display. The user may continue deleting compounds in this manner. When finished, the user may press [ESC] to return to the HAP sub-menu.

Before leaving the HAP sub-menu, the inlet concentration for each pollutant in the stream must be specified. This can be done from the Generate or Review options by highlighting each chemical and pressing [ENTER]. The pop-up menu is very similar to the one seen under Stream/ Parameters and may be used in the same manner.

Clear. This option will erase all stream data from memory. It is particularly useful if the user wants to review another stream from the same plant without typing in the plant identification information again.

Device

There are two options in the Device sub-menu: Type and Parameters. The purpose of this sub-menu is to specify the control device of interest and to input the variables to be used in the design and cost calculations for that control device.

Type. The control devices available are listed in a pop-up window. The devices will vary depending on the type of stream chosen previously. The desired device is chosen by highlighting it, using the arrow keys and pressing [ENTER]. Since the device parameters which must be supplied by the user vary for each control device, changing the control device will lose any information already input for the device parameters. Therefore, the user should be careful to save any work before changing the control device.

Parameters. The parameters form is divided into several sections, with section headings denoted by the use of all capitals. The parameters to be input by the user are listed under Design Related Parameters and Cost Related Parameters. The Permit Evaluation Parameters and Cost Estimates Parameters are calculated by CAT and cannot be changed by the user. Each parameter utilizes a pop-up window similar to the windows seen under Stream/Parameters. They contain the same four fields: Applicant, Recommended, and Calculation Values, and Checked.

An on-line help facility is available for this section by pressing

the [F1] key. The key acts as a toggle switch turning the help screen on and off. Many of the help screens were taken directly from the manual and may in some cases refer the reader to some specific part of the manual for additional help.

Review

There are four options in the Review sub-menu: Evaluate, Cost, View, and Print. The purpose of this sub-menu is to calculate the results and view them on the computer screen or write them to a file or to the printer for later reference.

Evaluate. The computer is instructed to perform the calculations after choosing this option. The screen shows the intermediate results and the results of the design calculations. The intermediate results are useful for tracing the calculations performed by CAT. The Permit Evaluation section lists the parameters also seen in the Permit Evaluation section of the Device/Parameter section.

Cost. Choosing this option produces a screen listing the total capital investments and components of the annual costs.

View. This option is used to view the final results on the computer screen. A pop-up window allows the user the choice of viewing the design, cost, or device portions of the report or all of the report. An example of a report for thermal incinerators is given in Table I.

Print. The print option behaves exactly as the View option described above except that it sends the output to a file or to the printer. The user is asked for the name of the file in which to place the report. If the default, PRN, is accepted, the output will be sent to the printer.

File

There are two options in the File sub-menu: Save and Recall. This option allows the user to save the evaluation in progress and recall it later.

Save. CAT asks for the name of the file in which to save the current review data. Any valid DOS pathname may be used. After saving the file, CAT automatically returns to the main menu.

Recall. CAT asks for the name of the file to read. The file must have been saved by the CAT program.

Clear

The Clear option allows the user to erase all data from the CAT program and begin again without having to leave the program and re-enter from DOS. The user is asked to confirm this choice before CAT erases all the data to prevent accidentally deleting all the information.

Quit

The Quit option allows the user to leave the CAT program and exit to DOS.

Several of the function keys have special uses throughout the program:

[F1] Used to activate an on-line help facility. The F1 key acts as a toggle switch and is also used to turn the help function off.

[F5] Clears the data field.

[F6] Clears to the end of the data field.

[F10] Used to exit the data form and save the entered data.

A tutorial manual, written for use with the computer program, contains step-by-step instruction for its use. It also includes appendices listing the inputs required for each control device as well as documentation of how the costs were calculated and their bases.

NJDEP's Planned Use of CAT

The NJDEP has recognized a need to automate air permit processing as much as possible in order to keep abreast of the demand for permit information as well as to maintain consistent engineering review techniques, including calculations, in an environment of high staff turnover and increasing numbers of applications being submitted (5000/year). The project was planned in two phases. Phase I was to develop a permit information system that would maintain a record of the applications received and to manage the routine administrative duties with little or no operator intervention. Phase I was designed and implemented on a PC system. The success of this system led to a second generation project on a Data General MV 4000 mini-computer which allows up to 64 users to simultaneously read or modify the database.

Phase II, automating the engineering review, will utilize CAT as a first step. NJDEP estimates that CAT will be initially used for 5% (250/year) of the permits received. These permits are categorized as the more difficult where a more detailed review is desired. Examples would be source operations emitting air toxics and also operations emitting volatile organic substances but which are not proposing emission controls.

To realize the automation objective, New Jersey must have a screening tool for the more routine applications. This would increase the number of applications being screened by computer up to 70% (3500/year) of the applications received. It is believed that CAT could be simplified for use as the screening tool by removing all variables not used in the calculations, supplying more recommended or default values, and eliminating the HAP specific information sections and replacing them with total volatile organic substance and total particulate fields. NJDEP and CTC are currently evaluating this possibility.

In implementation of the CAT program, NJDEP is revising the permit application forms to request the information needed to run the CAT program in order to assist the permit reviewer. It is anticipated that this may cause some difficulty for some applicants who have not fully specified their emission control system before applying for their permit to construct.

CTC Distribution of CAT

The CTC's goal with this and all other technical guidance projects is to make the products available nationwide. The CTC will notify State and Local Agencies of its availability through presentations at CTC-sponsored workshops, courses sponsored by EPA's Air Pollution Training Institute (APTI), other CTC mailings, and EPA's National Air Toxics Information Clearinghouse (NATICH) newsletter. Although, CAT is still in the review process and has not been cleared for distribution, many State and Local Agencies have expressed interest in using the program and anxiously await its release.

Future Versions of CAT

The CTC has already allocated resources for, and began work on, a second version of the program. Additions will include an electrostatic precipitator section, for a total of nine control devices, updates of the data bases included in the program, and improvements to make the program easier to use. It is hoped that comments will be received from users of the first version of the program to enable the project team to make the most effective decisions for modification of the program.

Acknowledgment

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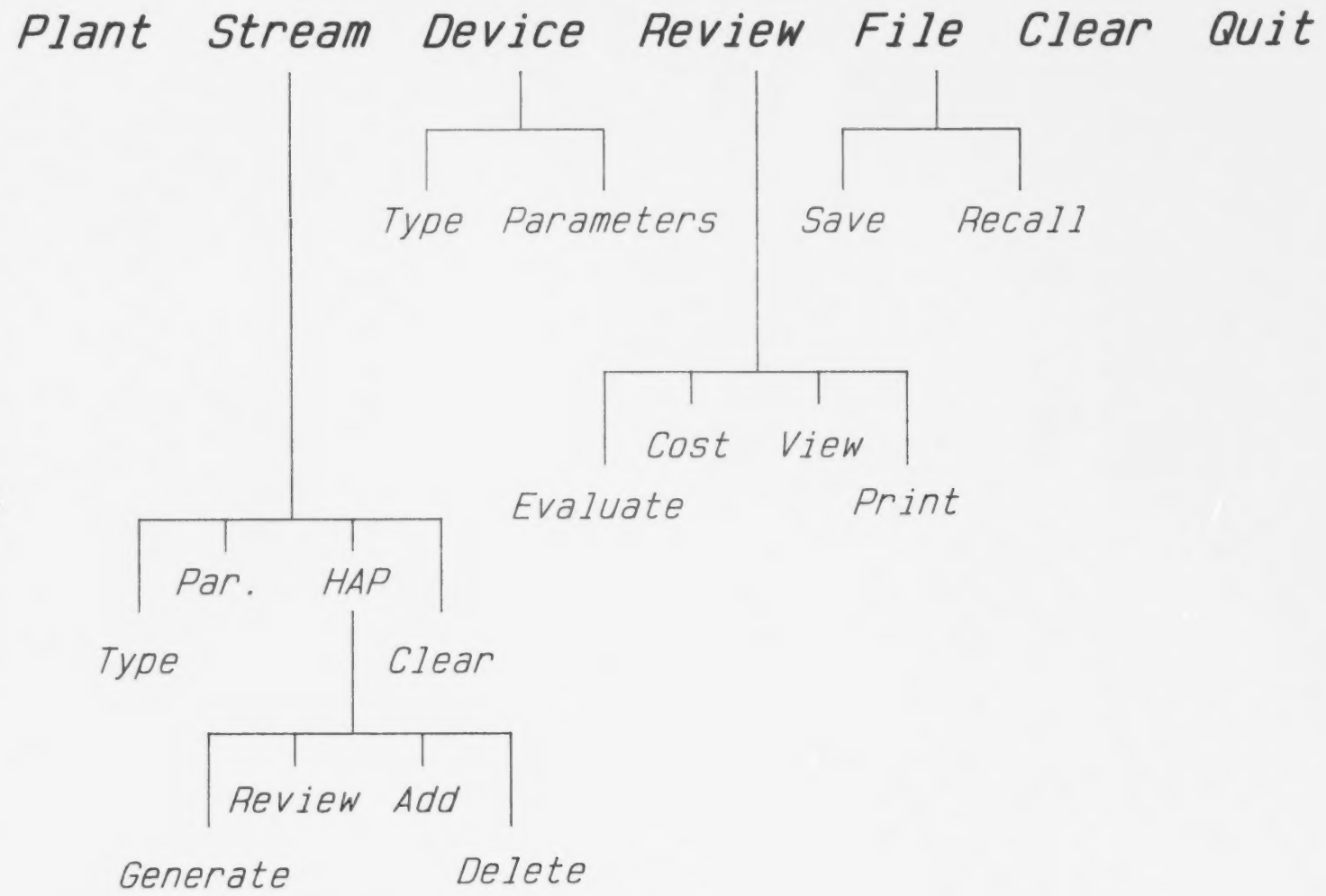

Figure 1. Tree structure of CAT.

Main Menu with Plant Form

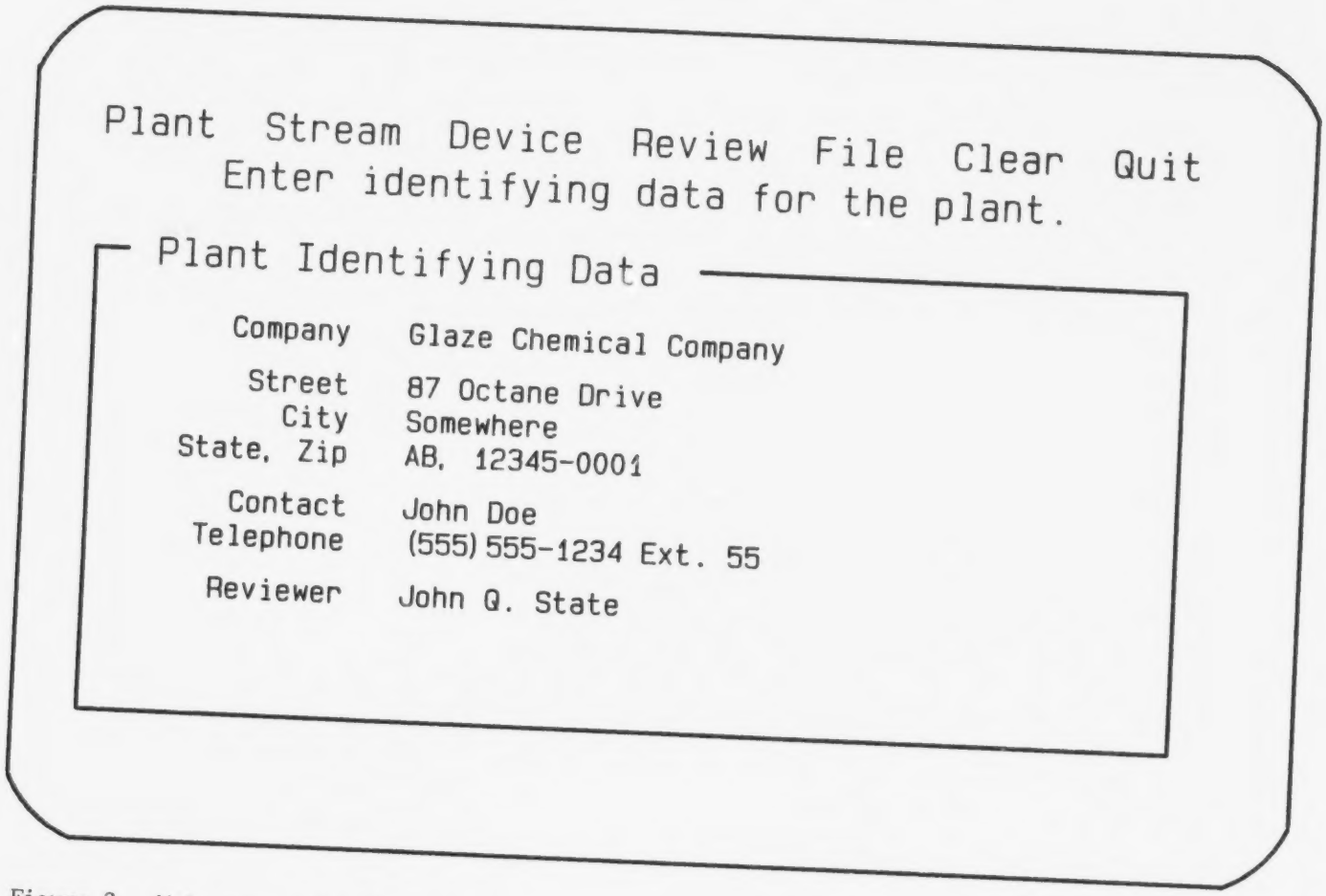

Figure 2. Main menu with plant form.

Stream/Parameters Form

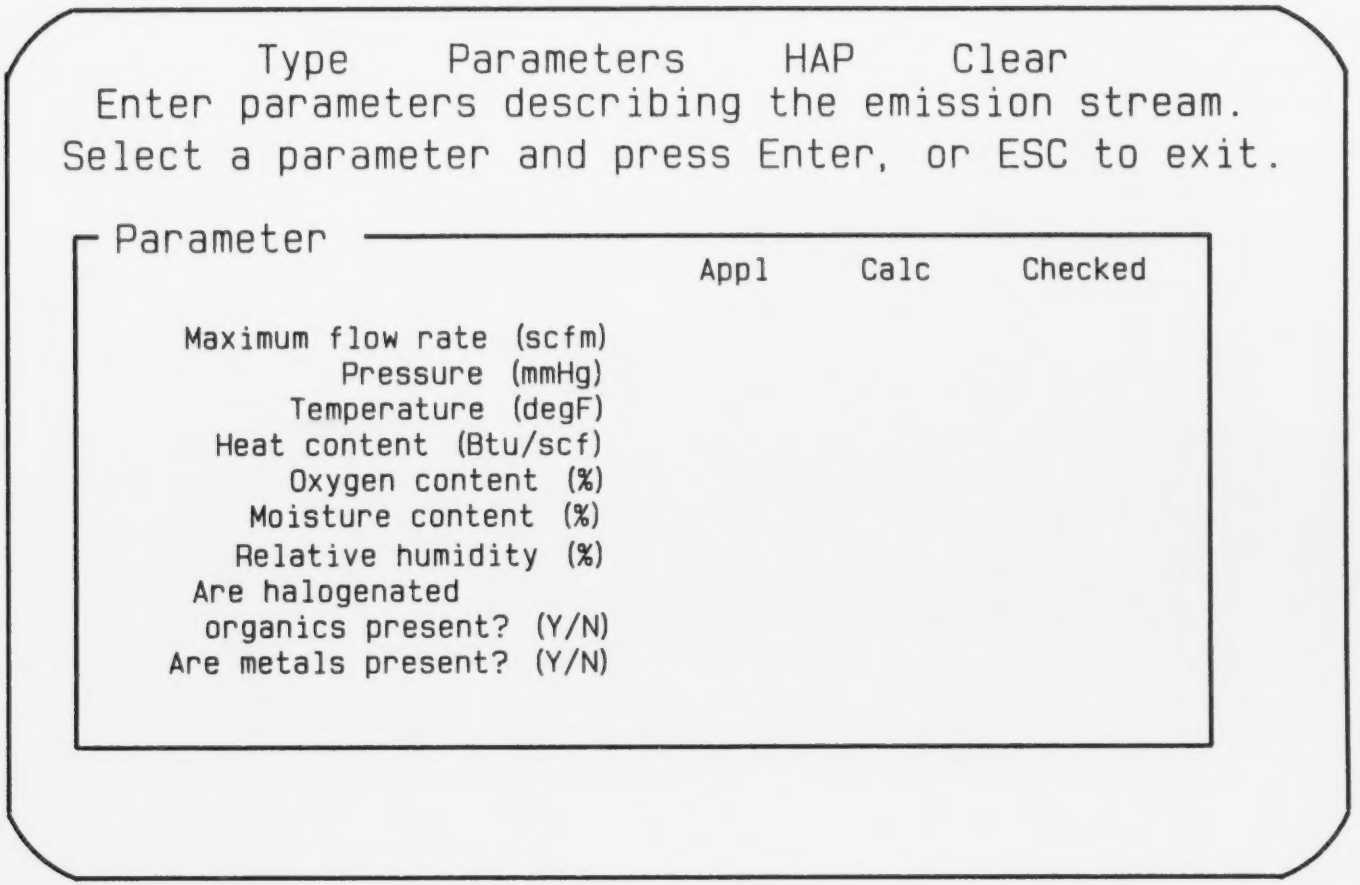

Figure 3. Stream/parameters form.

Pop-up Window for Parameter Input

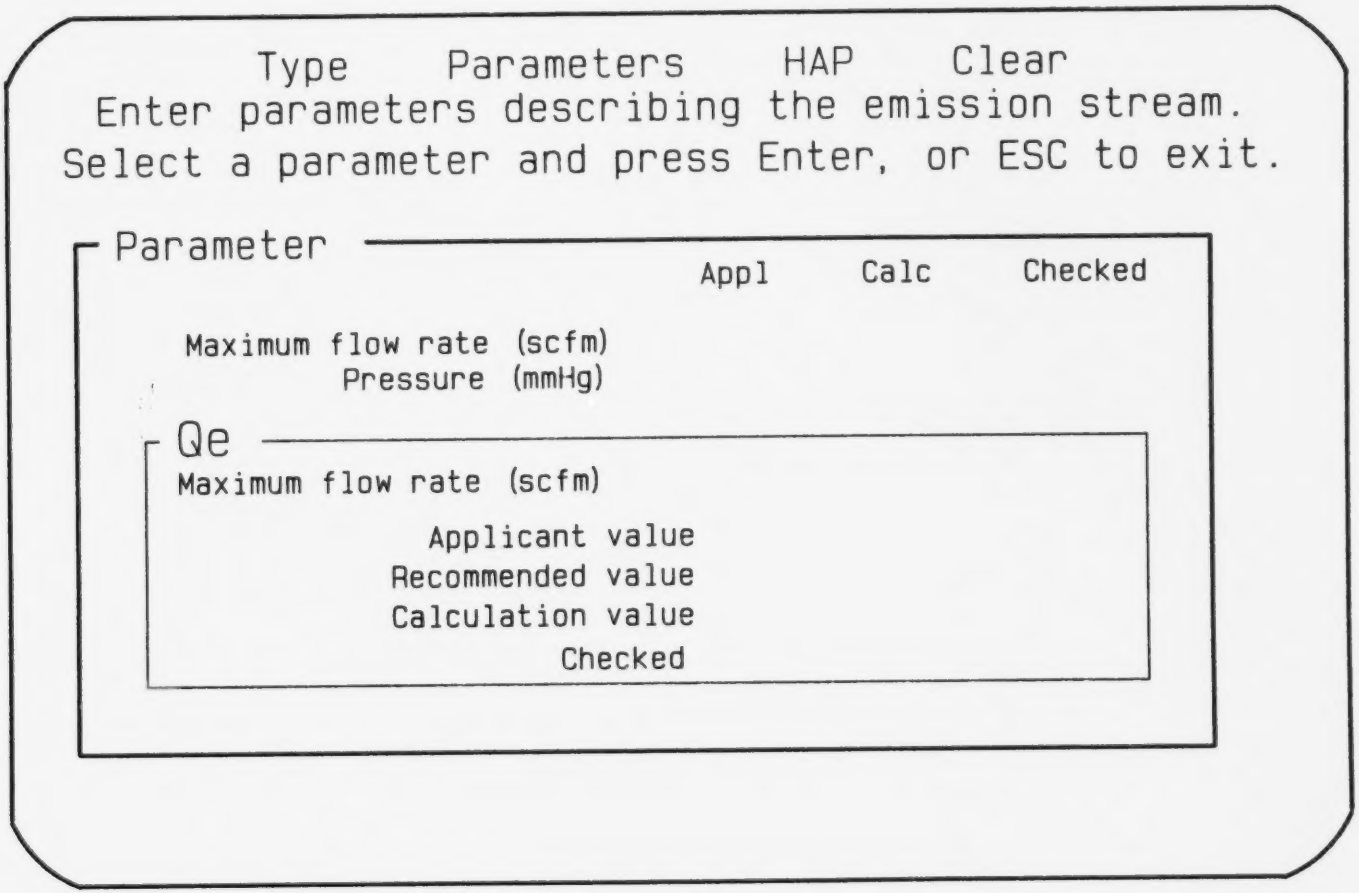

Figure 4. Pop-up window to enter parameter information.

Table I

CAT Analysis for Thermal Incinerator

Plant:

Glaze Chemical Company
87 Octane Drive
Somewhere, NJ 12345-0001

Contact: John Leake
Phone: (999) 345-0000 Ext. 27

Agency contact: John Q. Public

Emission Stream:

	Applicant	Calculation	Checked
Maximum flow rate (scfm)		15000	
Pressure (mmHg)			
Temperature (degF)		120	
Heat content (Btu/scf)		.4	
Oxygen content (%)		20.6	
Moisture content (%)		2	
Relative humidity (%)			
Are halogenated organics present? (Y/N)		N	
Are metals present? (Y/N)			

Hazardous Air Pollutant: 108-88-3 TOLUENE

	Applicant	Calculation	Checked
Inlet HAP concentration (ppmv)		73	
Molecular weight (lb/lb-mole)		92.15	
Specific heat equation constant A		0.576	
Specific heat equation constant B		93.493	
Specific heat equation constant C		-31.227	
Antoine equation constant A		6.95464	
Antoine equation constant B		1344.8	
Antoine equation constant C		219.48	
Heat of vaporization (Btu/lb-mole)		14262.60	

(continued)

Table 1 (continued)

	Applicant	Calculation Checked
DESIGN RELATED PARAMETERS.....		
Destruction efficiency (%)	99	
Combustion temperature (degF)	1800	
Residence time (sec)	.75	
Is a heat exchanger used? (Y/N)	Y	
Emission stream temp. after preheat (degF)	960	
Excess air (%)	0	
Area to Qe ratio		
Heating value of supplement. fuel (Btu/scf)	882	
Reference temperature (degF)	70	
COST RELATED PARAMETERS.....		
Combustion air flow rate (scfm)	0	
Duct cost ($/linear ft)	50	
Length of duct (ft)	100	
Total pressure drop (in H2O)	6	
Average equipment life (yr)	10	
Operator labor requirements (hr/shift)	.5	
Maintenance labor requirements (hr/shift)	.5	

Review of Thermal Incinerator:

TOLUENE:

The HAP inlet concentration is too low for a high destruction efficiency.

If the HAP concentration in the emission stream exceeds 25% of the lower explosive limit, then dilution of the emission stream will be required.

This device is not well suited to emission streams with highly variable flow rates.

Intermediate Results:

Cpair(1800.000000) = 0.020304
Cpair(960.000000) = 0.018941
Cpair(1800.000000) = 0.020304
deltaTLM = 840
Cpair(960.000000) = 0.018941

Permit Evaluation:

Supplementary heat requirement (Btu/min)	313486
Supplementary fuel flow rate (scfm)	355
Flue gas flow rate (scfm)	15355
Combustion chamber volume (ft3)	859
Heat exchanger surface area (ft2)	4279

(continued)

Table 1 (continued)

Total Capital Investment (June 1985 Dollars):	352098
Direct Operating Costs	
Natural Gas	778515
Electricity	39867
Operator Labor	6197
Operator Supervision	930
Maintenance Labor	6197
Maintenance Materials	6197
Indirect Operating Costs	
Overhead	7995
Property Tax	3521
Insurance	3521
Administrative	7042
Capital Recovery	57392
Net Annualized Cost (June 1985 Dollars):	917374